

CALIFORNIA LEAST TERN BREEDING SURVEY
SOUTH SAN FRANCISCO BAY
1981

submitted by
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INTRODUCTION

This report documents the field work conducted by members of the South Bay Institute for Avian Studies during 1981. The primary purpose of this study was to survey the breeding density and reproductive success of the California Least Tern (*Sterna albifrons brownii*) in the south San Francisco Bay. Special emphasis was placed on a complete description of nesting chronology of the Least Tern colony on Bair Island, San Mateo County, California. This colony was surveyed during the 1980 breeding season by this organization in accordance with stipulations expressed in United States Fish and Wildlife Service purchase order #11640-0152-0. This year's work was largely a continuation of the 1980 effort to record annual population fluctuations of this species and was supported by Fish and Wildlife Service purchase order #11640-0210-1.

BACKGROUND

The smallest North American member of the gull and tern family, the California Least Tern arrives each spring on the west coast of California and Baja California to establish breeding colonies. Once widespread and common in California coastal habitats from the Mexican border to Monterey County, this tern is currently threatened by numerous human-related environmental disturbances (Fish and Wildlife Service, 1980). Development and recreational use of coastal beaches and salt flats has resulted in the loss of nesting habitat, while the destruction of coastal wetlands through dredging and filling has resulted in the loss of feeding areas. By the late 1960's, the California Least Tern population was reduced to such a low level that the subspecies was declared endangered under state and federal laws. Perhaps more than any other species, the California Least Tern has served as a sensitive environmental indicator reflecting the destruction of California's coastal wetland (Atwood, 1978).

Data on the San Francisco Bay population of California Least Terns is sparse since they are a relatively new nesting species in this area. Nesting was first suspected in 1959 but was not confirmed until 1967 (Chandik and Baldrige, 1967). That year a single colony of three nests was found in Alameda, Alameda County. Two years later two additional colonies were located, one in Alameda County (Bay Farm Island), the other on

Bair Island, San Mateo County (Anderson, 1970). Historical nesting of the California Least Tern in the San Francisco Bay area is summarized in Figure 1. A summary of California Least Tern nesting on Bair Island can be found in Table I. The Bair Island colony site was chosen for extensive study because of its isolation, the proximity of several natural predators, and its suitability for artificial nest support experiments (Rigney and Emery, 1980).

VEGETATIVE DESCRIPTION

Bair Island is a 560 hectare tidal island complex located approximately 1.5 kilometers north of the Port of Redwood City. Bordered on the north by the San Francisco Bay, Bair Island is separated from all land masses by three deep water sloughs. There appear to be no resident mammalian predators and because of the tidal conditions surrounding the island, access for mainland predators is extremely difficult (Rigney, et. al., 1980). The majority of Bair Island is owned by the Mobil Oil Corporation, a 100 acre portion of which is leased to the San Francisco Bay National Wildlife Refuge. The remainder of Mobil Oil's lands on Bair Island are under consideration for housing and industrial development.

Dikes and levees remain from salt evaporation production carried on by the Leslie Salt Company. Since salt harvesting was discontinued, the northern portion of the island has been divided into three distinct habitat types: 1) alkalai flats, 2) Salicornia and Baccharis on dredge deposits and 3) reclaimed tidal marsh. Figures 2 and 3 describe these habitat types and the location of the California Least Tern colony in an abandoned salt pond. The environment of the immediate vicinity of the colony is characterized by extremely flat terrain of mud-silt composition with a thick, crystalline crust on the exposed surface. Exposure to sun and harsh winds are deemed to be potentially serious problems for this colony as only small stands of pickleweed exist for protection.

MATERIALS AND METHODS

On April 26, 1981, prior to the onset of breeding, members of the South Bay Institute for Avian Studies, with the assistance of personnel from the San Francisco Bay National Wildlife Refuge randomly placed 15 to 20 piles of weathered shell mounds in the colony site. The mounds, it was hoped, would be attractive nesting substrate for the terns. The mounds were approximately one meter in diameter and 20 and 30 centimeters high. Twelve spanish roof tiles were also randomly placed in the colony. Inverted, it was hoped the tiles would provide shade for young terns. Some tiles were also placed in pairs on their sides in a "L" shape to serve as windbreaks.

During the 1980 breeding season, members of the Institute placed twelve tires in the Bair Island colony site to serve as elevated nest platforms. The tires were filled nearly to the top with gravel and topped off with a layer of shell deposits

from one of the many spoil accumulations on the island. Six decoys constructed of styrofoam and painted with exterior latex paint were placed in the interior of the colony to attract Least Terns to the site (See Figure 4). The nest platforms were in good enough condition for use again this year by the terns and the decoys were again placed in the colony during the 1981 breeding season.

Access to the island was accomplished by the use of a 12 foot aluminum boat equipped with a 7.5 hp. engine. High tides governed the time of day the field work was conducted. A 60X spotting scope and 7 X 35 binoculars were used to observe the colony for a period of approximately one-half hour before entering the colony. Census work involved marking each new nest with a numbered tongue depressor and recording the progress of each nest.

Nest scrapes were located by either observing the behavior of adult terns flying overhead or by noting locations of birds on the ground. Photographs of each nest were taken to document nesting progress. From 2 May to 2 August, a total of 12 trips were made to the Bair Island colony, one of which was overnight to observe possible night predation

RESULTS

I. DATES OF ARRIVAL

A. BAIR ISLAND

Five adult California Least Terns were first sighted on 2 May, 1981 in the immediate vicinity of the Bair Island colony site. Reports from investigators at the Alameda Naval Air Station colony confirmed their return there at approximately the same time (per. com. Laura Collins and Paul Kelly). On 16 May, three adult Least Terns were again sighted, one of which was circling over the colony site issuing characteristic alarm calls. The terns' arrival in 1981 was a full month earlier than the previous year. In 1980, the Bair Island colony site was partially flooded due to a broken levee. The accumulation of water in the evaporator may have delayed the nesting cycle that year.

B. OTHER REFUGE LOCATIONS

Least Terns were again observed in the vicinity of a colony site located near Coyote Hills Regional Park. This site was described in detail in Rigney and Emery, 1980. Located along a public trail, this colony has been subject to human disturbance problems in past years. Less than four days after two adult Least Terns were sighted at the site on 8 May this year, the trail was closed by the East Bay Regional Park District. On 12 May, 1981, eight adult Least Terns were observed in flight over the colony site (per. com. Sally Walters). On 20 May nine terns were counted near the colony and at least two birds engaged in courtship display and fish exchange. No nests were found at this time or on previous census periods.

Observations by Roy Lowe, biologist for the San Francisco Bay National Wildlife Refuge on 1, 15 and 17 June revealed no

tern activity at the colony site. The third week in June the public trail near the colony was again reopened. On 26 June, 1981 one immature plumaged bird at least one year old was observed at the site. No other Least Terns were sighted at the Coyote Hills colony during the remainder of the breeding season. It is presumed that the terns which were in evidence in May and early June either did not breed this year or joined other colonies. Adjacent areas containing suitable nesting habitat were searched by Refuge and Institute personnel during May and June with no sightings.

II. NEST LOCATIONS

Throughout the 1981 breeding season, 12 of the 23 total active nests in the Bair Island colony were located on shellmounds approximately 15-20 feet apart in the interior of the colony (Figure 4). The nests were usually centered atop the shellmound, appearing as a shallow scrape. The young that were later seen in proximity to these nests were all observed in small stands of pickleweed just north of these nest sites. Eight nests were located in footprints or shallow depressions along the northern and eastern boundaries of the colony. These boundaries appear as narrow, dry sloughs approximately 10 feet wide and form a U-shape around the colony site. Four of these eight nests were within six feet of one another, while nests #1, 26, 17 and 18 were approximately 50 feet away from the rest of the colony (Figure 4). Two nests (#23 and #25) were located in small stands of pickleweed. Nest #25 was near the decoys in an area of high nest concentration. Nest #23 was located in a small slough on the northern edge of the colony where many juveniles were later spotted. One nest (#16), was located on a tire in the southern end of the colony.

III. NESTING CHRONOLOGY

Three nests were found on 30 May containing one, two and three eggs respectively. The number of active nests increased steadily until 20 June when 17 active nests were located and marked. It is important to note that the sites where young were found were marked although they were not considered to be active nests. These sites are represented by numbers 10, 20, 21, 22, 27, 29 and 30 in Figure 4.

The peak of the 1981 breeding season occurred on 20 June when a total of 17 active nests containing 33 eggs and 4 young were observed. By 7 July nine of the original 17 nests were empty. Four new nest sites and eight previously counted sites were censused on that date. One additional nest was discovered on 12 July and 2 August respectively. However, the majority of nesting was completed by 2 August. A sharp decline from 30 to 15 adult Least Terns in the vicinity of the colony on 1 August marked the final stages of the 1981 breeding season. Prior to this date, field counts of adult terns had held steady at about 30 individuals, which corresponded closely to the number of nesting pairs. Table II describes the progress of each Least

Tern nest on Bair Island for 1981.

IV. MORTALITY

Data from the 1980 nesting season on Bair Island indicated that unless nocturnal predation was excessive, mortality from natural predation was insignificant (Rigney et. al., 1980). On June 26, 1981, four investigators camped approximately 150 yards south of the Least Tern colony with the intention of assessing potential night predation. No alarm calls were heard or incidences of predation observed during this observation period. Several potential predators reside on Bair Island including the Burrowing Owl, Short-eared Owl, Black-crowned Night Heron, Marsh Hawk and the White-tailed Kite. Marsh Hawks were observed on a few occasions flying high above the colony and on one occasion a single Black-crowned Night Heron was observed being chased from the nesting area by adult terns. On every census after 20 June, gulls were observed flying above the colony. Such gull flights caused alarm responses from most of the adult terns in the colony. Although the gulls were never observed actually landing in the colony the frequency of their observation close to the colony suggested the possibility that gulls may be a predator of tern chicks. Of the five young found dead, four were found in the nest. These juveniles were less than three days old and bore no evidence of wounds. Suspected causes of death were exposure and dehydration. The fifth chick was found on the eastern periphery of the colony beneath a stand of pickleweed and is being tested for pesticide and heavy metal contamination.

NESTING SUCCESS

The precocial habits of young terns inhibits the accuracy of census work. Tern chicks are capable of wandering about the colony two days after hatching. As most of our visits to the colony occurred a week or more apart, it is probable that substantial numbers of young hatched and left the nest between census periods and were thus never associated with a specific nest. Of the 45 total number of eggs laid in the 1981 season, 12 eggs from eight different nests (26.6% of all eggs laid), exceeded the normal incubation time and were thus considered inviable. A total of 22 young were located, 17 were found alive and five were found dead in or near the colony. Twelve eggs either hatched between census periods or otherwise disappeared from nests. With the fate of these 12 eggs unaccounted for it is difficult to project the success rate for this colony. However, a maximum fledging rate can be extrapolated. If this is done the Bair Island Least Tern colony fledged a maximum of 29 birds from a total of 45 eggs laid in 23 nests, for a maximum fledging rate of 0.79 birds per nest.

DISCUSSION

I. EARLY NESTING ONSET

The early onset of nesting and the more stable population numbers throughout the 1981 nesting season were perhaps related to a dryer and more temperate spring. Last year, a late season storm in late June contributed partially to the abandonment of the Alameda Naval Air Station Least Tern colony. Within two weeks of that abandonment, the breeding population on Bair Island doubled, presumably from an influx of birds from Alameda. Additionally, this late increase in nesting delayed the peak nesting date to 25 July, 1980. This year the peak of the nesting season on Bair Island was 20 June, a full month earlier. This sequence was more in line with the typical Least Tern nesting pattern.

II. ARTIFICIAL NEST ENHANCEMENT

Prior to the breeding season in 1980, 12 tires were placed in the central portion of the colony to provide elevated nest platforms for the terns. This was done because water had accumulated in the evaporation pond used by the terns for nesting. Four of these nest platforms were used by the nesting terns early in the 1980 season. In order to offer the birds alternate elevated nesting substrate, 15-20 shellmounds were distributed randomly in the same areas as the tires with the same intention of protecting the eggs from moisture and the accumulation of mud on the surface of the eggs. These mounds consisted of the same materials used to fill the tires but lacking the supportive structure of the tire. As a consequence the shellmounds were much closer to the ground. The Least Terns' preference for the shellmounds was well demonstrated with 12 of the 23 (53%) nest sites occurring on these mounds. Only one active nest was located on a tire during the 1981 season. The need for artificial nest enhancement in the Bair Island colony appears to be substantiated by the fact that during the 1981 breeding season 61% of the nesting pairs chose artificially constructed nest substrates.

III. DECOYS

The effect of the decoys on the formation of the colony is difficult to analyze. Since the majority of nests this year were located in close proximity to the decoys it is presumed that they did have an attractive effect on the terns.

IV. LEAST TERN AND CASPIAN TERN INTERACTION

Last year's hypothesis that the Caspian Terns' zone of defense encompassed the Least Tern colony was reaffirmed this year. Both species together mobbed intruders such as gulls, Marsh Hawks and census parties. The aggressive presence of the

Caspian Terns probably increased the survival rate of young Least Tern chicks. This hypothesis is further supported by the presence of juvenal Least Terns in the vicinity of the Caspian Tern colony. Three young Least Terns were observed on 25 July flying near the Caspian colony and one was observed in the same area on the ground.

V. TILES

The effect of placing the spanish tiles in the colony appears minimal. No young were ever observed utilizing the tiles for protection. A close examination of the ground around the tiles failed to show any signs of droppings, tracks or any other signs that young birds had sought refuge around the tiles.

VI. LOW HATCHING SUCCESS

The fact that 26.6% of the eggs laid during 1981 did not hatch raises several questions. Past speculation as to the cause of low hatching rate for the Bair Island colony centered around the possibility that accumulated mud on the surface of the egg inhibited respiration and the consequent death of the embryo. By providing elevated nesting mounds the possibility for respiratory inhibition was essentially eliminated. Whether the eggs failed to hatch due to the death of the adults, nest abandonment, contamination or infertility in the adults is unknown. Four of the eight nests which failed to hatch all eggs, appeared to have been wholly abandoned. All of these four nests contained eggs on 20 June, and the eggs remained through 2 August. Three nests originally contained two eggs, one of which either hatched or disappeared. The second egg in these nests never hatched. The eighth nest, first discovered on 7 July, contained only one egg. On 2 August, the single egg was found in the nest broken and empty.

Observing the interactions between the young terns and adults for the first few days after hatching might assist in answering some of the following questions. In a clutch of two or more eggs, if the first egg hatches and then wanders far, do the adults abandon the second and third egg(s) in favor of caring for the one young bird? Is there an inappropriate ratio of females to males resulting in a high number of infertile eggs being laid? Although these questions are beyond the scope of this report, perhaps with better observational equipment some of these questions might be answered in the future.

RECOMMENDATIONS

- 1). It is essential that the integrity of the levee system surrounding the Least Tern colony on Bair Island be maintained to prevent flooding of the nesting area. One levee appears to be on the verge of breaching and should be strengthened.
- 2). Continue adding shell deposits to enhance the suitability of the substrate.
- 3). A program of color-banding young Least Terns should be instituted during 1982 to differentiate between terns nesting on Bair Island from those nesting at the Alameda Naval Air Station.
- 4). Predation problems should be carefully monitored.
- 5). Regular censusing of the Bair Island colony should take place during the 1982 breeding season. Concerted efforts should also be made to locate new or unreported nesting colonies in the south San Francisco Bay.
- 6). Efforts should be made to locate primary feeding areas of nesting Least Terns and chemical analyses should be made of food samples, egg shells and dead young or adults.

ACKNOWLEDGEMENTS

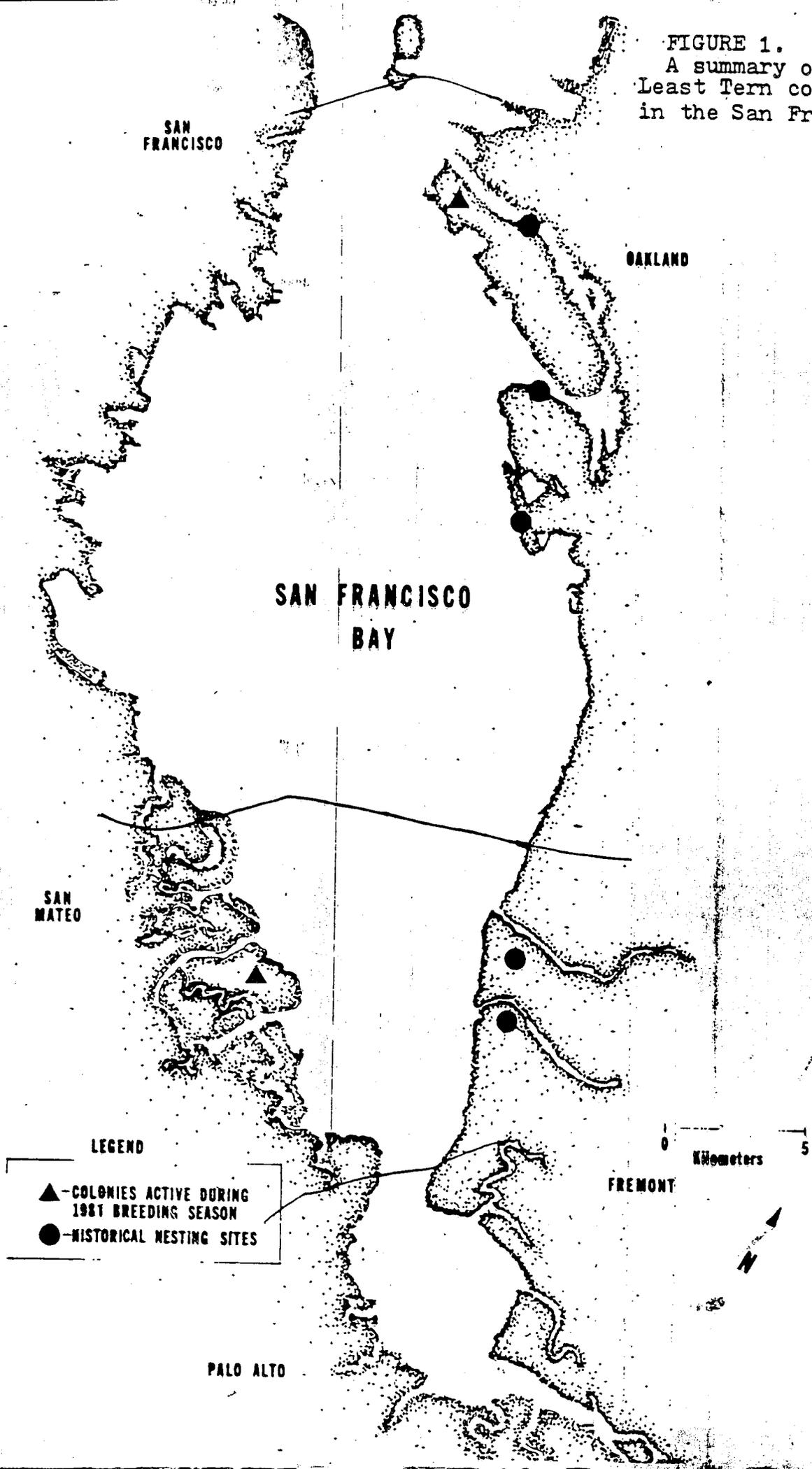
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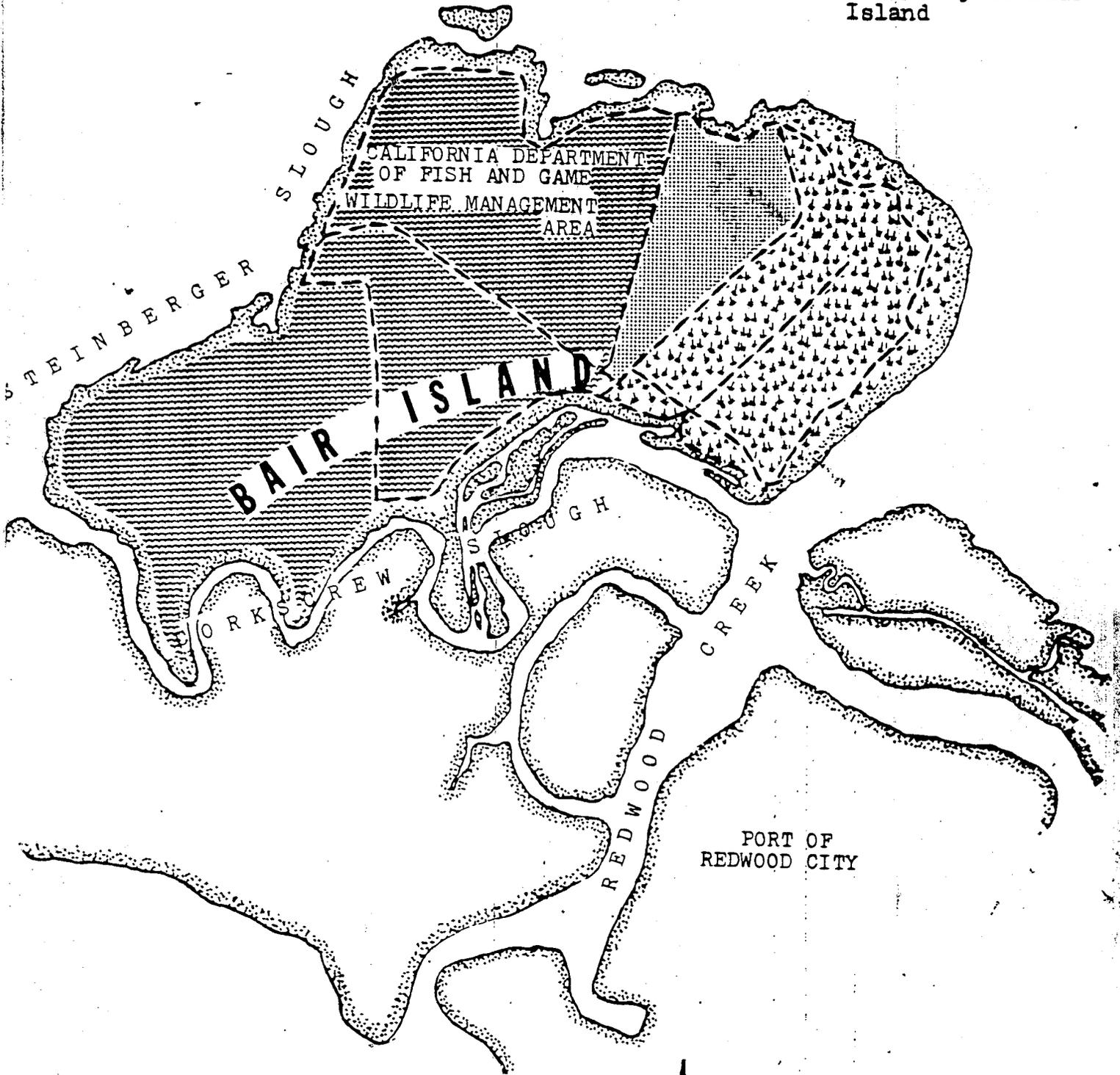
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FIGURE 1.
A summary of Calif.
Least Tern colony sites
in the San Francisco Bay



S. F. B A Y

FIGURE II
Habitat inventory of Bair
Island



Salicornia and Baccharis
on dredge deposits



alkalai flats



reclaimed tidal marsh



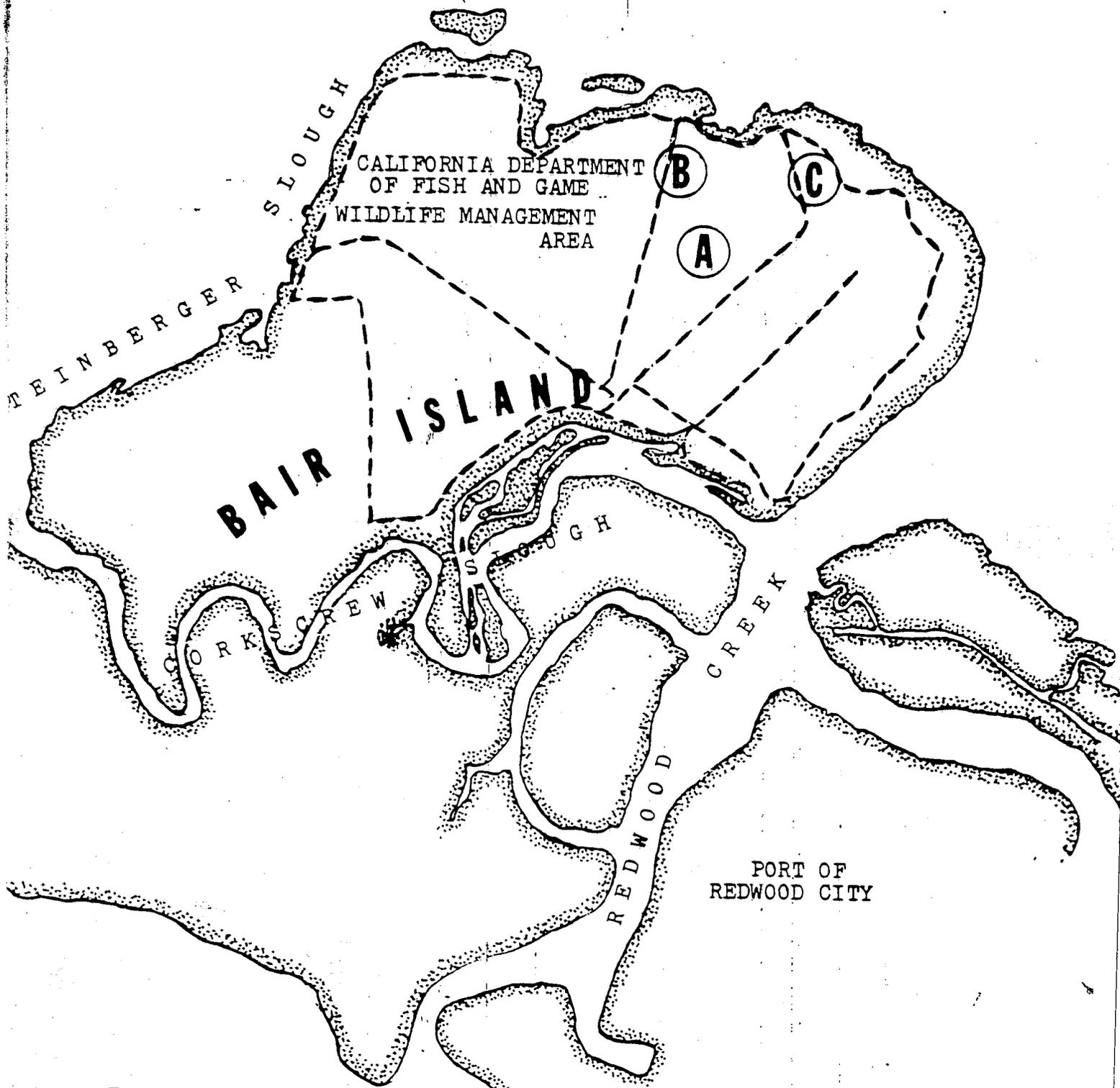
SCALE



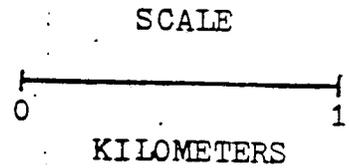
KILOMETERS

S. F. BAY

FIGURE III



- (A)** CALIFORNIA LEAST TERN COLONY
- (B)** CASPIAN TERN COLONY
- (C)** HERON COLONY



██ LIKE NEST PLATFORMS

▲ NEST SITES

△ LOCATION OF YOUNG

--- FOOTPRINTS

FIGURE IV

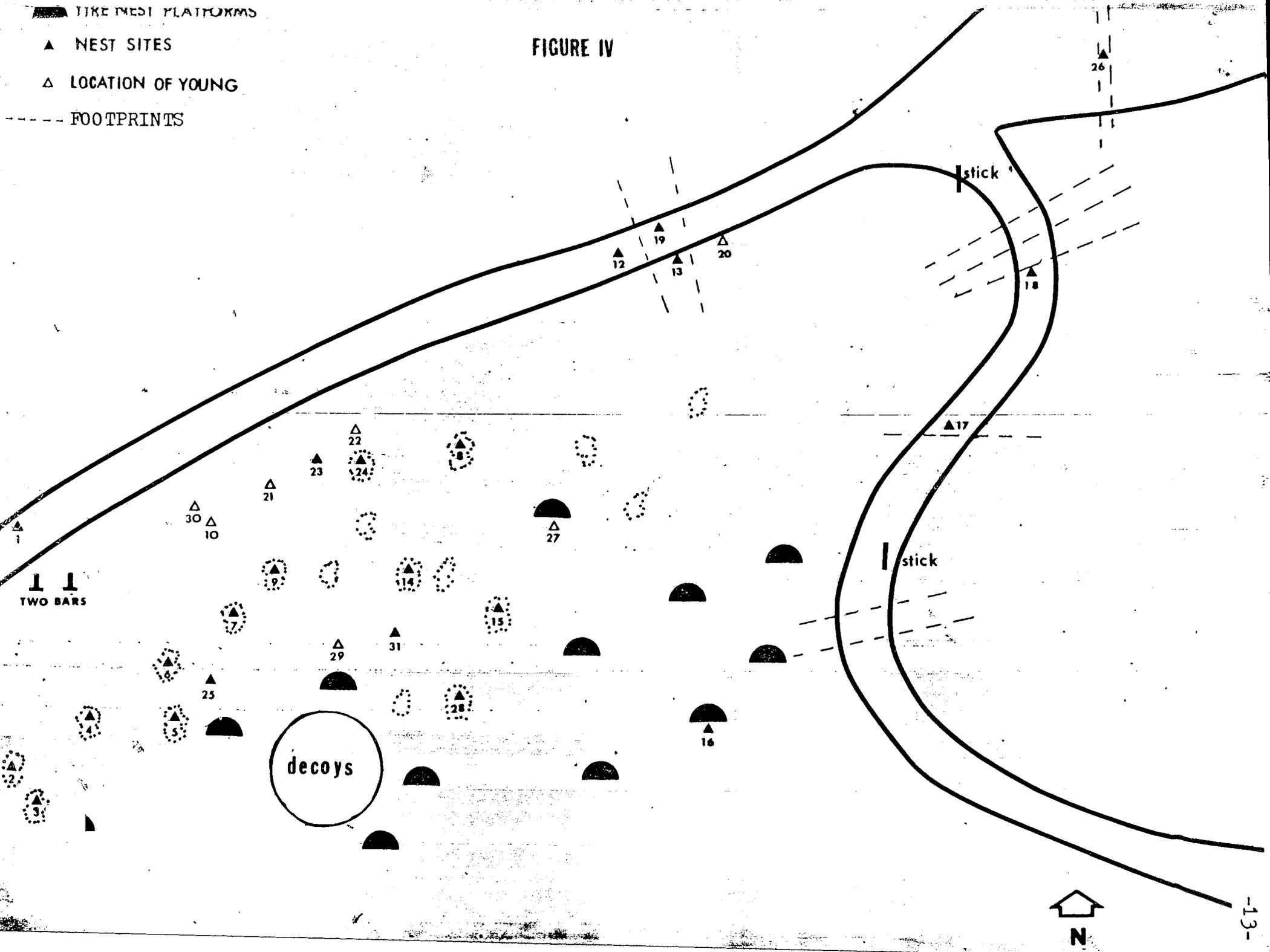
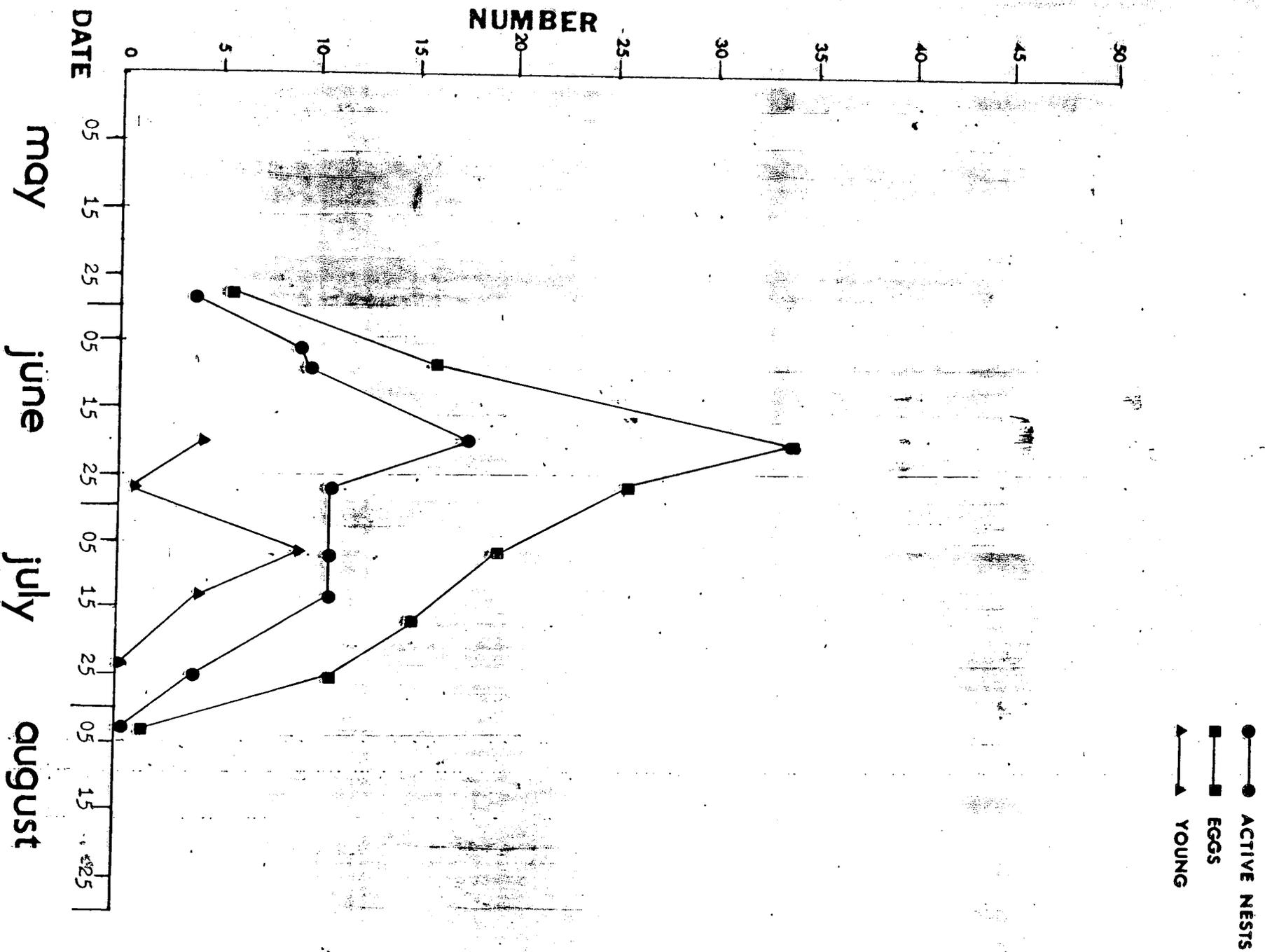


FIGURE V



HISTORICAL SUMMARY OF CALIFORNIA LEAST TERN NESTING
ON BAIR ISLAND

YEAR	NO. OF BREEDING PAIRS
1969	15
1970	8
1971	0
1972	0
1973	0
1974	8
1975	14
1976	14
1977	1
1978	0
1979	6-8
1980	38
1981	23

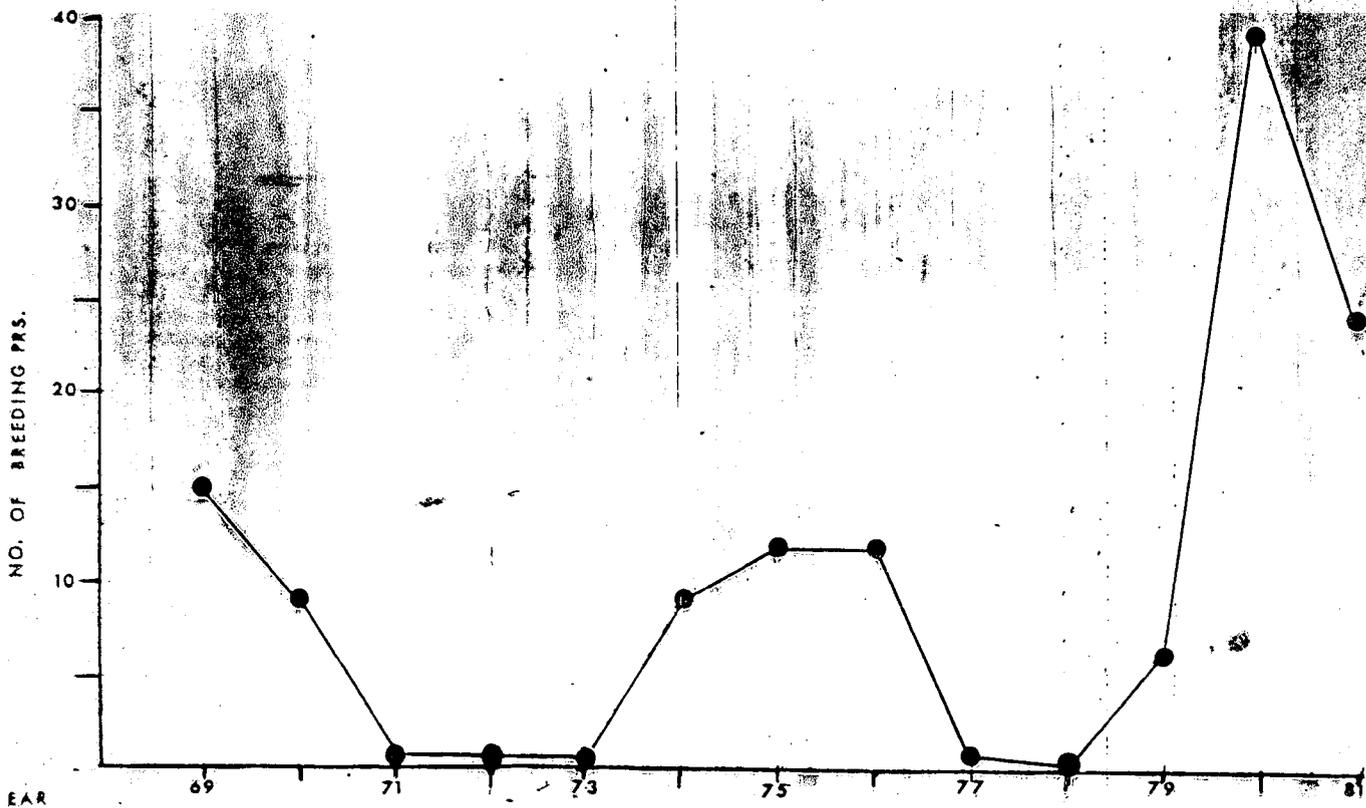


TABLE II

nest site	date						eggs	clutch size	young	dead young
	06-20	06-26	07-07	07-12	07-25	08-02				
1	2e						2	2	0	0
2	3e	2e-1y					3	3	1	0
3	2e	2e	2e	1y-1dy			2	2	1	1
4	1e	1e	1e	1e	1e	1e	1	1	0	0
5	2e	1e	1e	1e	1e	1e	2	2	0	0
6	3e	3e					3	3	0	0
7	3e	3e	3e	3e	3e	3e	3	3	0	0
8	2e	2e					2	2	0	0
9	2e						2	2		
12	2e	2e					2	2	0	0
13	2e	1dy					2	2	0	1
14	2e	2e	1y				2	2	1	0
15	2e	2e	2e	2e	2e	2e	2	2	0	0
16	1e	2e	2e	2y			2	2	2	0
17	1e-1y						1	1	1	0
18	2e	2e					2	2	0	0
19			2e	2e	1e-1y	1e	2	2	1	0
23			1e-1y	1e	1e	1e	1	1	1	0
24			2e	2e	2e	2e	2	2	0	0
25			1e	1e	1e	1e (br)	1	1	0	0
26			2e	2e	2e	1dy	2	2	0	1
28				2e	2e		2	2	0	0
31						2e	2	2		
									9	2

young not associated with a nest

LEGEND

e = eggs
 y = young
 dy = dead young
 (br) = broken egg

totals

45	x=1.95	17	5
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